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Abstract

Background

Emergency department data offer more representative deliberate self-harm (DSH) information than inpatient admission data. However, emergency department data may underestimate DSH if some records coded "undetermined" (UD) represent DSH.

Data and methods

The data are from the National Ambulatory Care Reporting System. A total of 24,437 Ontario emergency department records for 2001/2002, coded DSH or UD, were analyzed. Age- and sex-specific estimates were compared under alternative DSH definitions.

Results

For every two emergency department presentations coded DSH, another was coded UD. Cut/Pierce injuries and poisonings coded UD appeared to represent DSH more often than did UD presentations involving other injuries. Among index episodes coded UD, the rate of subsequent DSH presentation was nearly ten times higher when cut/pierce injury or poisoning was involved. Including presentations coded UD among those coded DSH increased the 12-month cumulative incidence of DSH by up to 60%.

Interpretation

Some emergency department presentations coded UD likely represent DSH.

Keywords

hospital emergency services, hospital records, injury, Ontario, patient admission, poisoning

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Worldwide, suicide is among the three leading causes of death of people aged 15 to 44.[1] In Canada, approximately 3,700 suicides are recorded annually–more deaths than from transport accidents and assaults combined.[2]

Deliberate self-harm (DSH), defined as intentional self-poisoning or self-injury,[3] is a closely related public health problem. For example, emergency department data for Alberta showed nearly 250 presentations for DSH per 100,000 population in 2000/2001.[4] Such presentations increase an individual's risk of subsequent suicide,[5] and repetition is common. According to a systematic review of published follow-up data from 90 observational and experimental studies, in the following year, around 2% will die by suicide and 16% will return to hospital for DSH.[6]

Both government and stakeholder groups have identified the need for improved mental health surveillance,[7,8] including suicide attempts,[9,10] but DSH monitoring is rare in Canada. Consequently, existing data sources should be considered. Emergency department administrative records are particularly valuable because they offer more representative DSH information than do inpatient admission data. In fact, fewer than half of emergency department presentations identified as DSH are admitted to hospital.[4,11] However, the quality of emergency department data for DSH reporting has not been thoroughly investigated.

DSH is often identified in administrative data by the presence of International Classification of Diseases (ICD) "self-inflicted" external cause of injury codes (E codes). Research based on inpatient admission data suggests that DSH is sometimes misclassified. A review of records from a Canadian teaching hospital found that DSH was under-recorded by 63% in data for self-poisoning admissions.[12] A New Zealand study demonstrated that, compared to individuals with no previous hospitalizations, those admitted for injuries and poisonings with "undetermined" (UD) E codes were at increased risk of subsequent DSH admission and suicide (relative risks 13.7 and 164.1, respectively). The authors speculated that some admissions that were coded UD may have represented DSH that was withheld by the individual or overlooked by the clinician,[13] although this may also reflect a more general problem with non-specific coding in hospital data (for example, because of incomplete or illegible chart documentation).[14]

Still, together, these results imply that research and reporting based entirely on DSH codes (excluding UD codes)[4,15,16] may be problematic.

Mortality data, too, have been shown to underestimate suicides,[17] partly because some suicides are coded UD (a finding that has had implications for how suicides are identified).[18-23] A similar tendency might influence DSH research and reporting; that is, as is the case with suicide, the stigma associated with DSH might produce consistent patterns of misclassification (false negative rate exceeds false positive rate).

This article uses population-based emergency department data from the province of Ontario to investigate the possibility that some emergency department presentations coded UD may actually be DSH. First, these UD presentations, as well as those coded DSH, will be quantified by method of injury.

Second, an exploratory analysis will compare index episodes coded UD or DSH for rates of subsequent DSH presentation, overall and by method of injury in the index episode.

Third, given that cut/pierce injuries and poisonings account for the majority DSH emergency department presentations,[3] factors associated with coding DSH rather than UD for such presentations will be examined. Specifically, the effects of method of injury, acuity and admission to hospital will be tested, along with whether they explain why males younger than age 65 are less likely than their female counterparts to be coded DSH.[12] We hypothesize that DSH coding may be more common in high-acuity presentations if lethality is interpreted as intent, or because the associated intensity of clinical contact facilitates detection and chart documentation. Similarly, presentations admitted to hospital may be coded DSH more often because the admission process produces more detailed clinical information, for example, because psychosocial assessment are more likely to occur.[24] The analyses will account for variations between hospitals in the coding of DSH versus UD, reflecting institutional differences in clinical[25] and/or administrative practices.

Finally, the effect that including presentations coded UD as probable DSH has on the 12-month cumulative incidence and relative risk (female versus male) of DSH will be illustrated.

Data and methods

This is a retrospective cohort study based on Ontario emergency department data from the National Ambulatory Care Reporting System (NACRS) for the 12-month period from April 1, 2001 through March 31, 2002. These data, coded and abstracted from the health record after an emergency department presentation is complete, contain demographic and clinical information about the visit, including up to 6 diagnosis codes and 2 E codes.

During the study period, 162 Ontario hospitals submitted complete data; 8 submitted data for only some months; and 5 did not submit data. Any emergency department presentation by an Ontario resident aged 12 or older that listed either a DSH (ICD-9: E950-959) or an undetermined (UD) (ICD-9: E980-989) E code was included in the study sample. The final dataset consisted of n=24,437 presentations by n=20,20 individuals. Multiple presentations by one individual were identified with a unique anonymous identifier. For individuals with more than one presentation during the study period, the first presentation was selected as their index episode.

The following variables were assigned to each record: 1) E code, categorized hierarchically as either DSH or UD; 2) method of injury, categorized hierarchically as cut/pierce (ICD-9: E956/E986), poisoning (medicinal) (ICD-9: 960-979, E950.0-.5/E980.0-.5), poisoning (non-medicinal) (ICD-9: 980-989, E950.6-952/E980.6-982) or other injuries; 3) acuity, according to the Canadian triage and acuity scale (CTAS),[26] categorized as resuscitation/emergency, urgent, or less urgent/non-urgent; 4) admission to hospital, categorized as "yes" where the NACRS record could be linked to a subsequent admission record in the Discharge Abstract Database or "no"; 5) age, categorized as 12 to17, 18 to 64, or 65 or older; and 6) sex. Information specifying the institution in which the presentation took place was also retained.

Subsequent DSH emergency department presentation rates were calculated per 100,000 person-years, by method of injury and E code at the index episode. The numerators were the number of individuals with subsequent DSH presentation (before the end of follow-up, March 31, 2002). The denominators were the sum of person-years, calculated either from the emergency department discharge date or inpatient discharge date (where admitted) of the index episode up to a subsequent DSH event or to end of follow-up. Each individual contributed 0 to 364 days to the denominator. Individuals who died on arrival in the emergency department or while admitted to hospital at the index episode were excluded from this analysis (n=161). Effects were estimated with rate ratios (RRs) and their 95% confidence intervals (CIs).[27]

DSH versus UD coding in index episodes involving cut/pierce injury or poisoning was analyzed using multilevel logistic regression modeling. The proportion of index episodes identified as DSH by institution ranged from 0% to 100% (median 76.2%; interquartile range 62.0% to 87.5%); this variation was accounted for with a random intercept. Effects of individual-level variables were allowed to vary across hospitals (with random slopes). Effects were estimated with odds ratios (ORs) and their 95% CIs, first from unadjusted models, then from an adjusted model that included all variables listed.

The impact of alternative DSH definitions was demonstrated with age-

and sex-specific 12-month cumulative incidence estimates. The numerators were the number of individuals identified as having had a DSH emergency department presentation during the study period, based on three definitions of DSH. Each definition included records coded DSH, but their treatment of UD presentations differed. Definition 1 (DSH1) excluded UD presentations completely. Definition 2 (DSH2) included UD presentations if they involved cut/pierce injury or poisoning. Definition 3 (DSH3) included all UD presentations, regardless of method of injury. The denominators were age- and sex-specific population estimates, based on 2001 Census estimates for Ontario.

The analyses were carried out in SAS,[28] except for the multilevel models, which used HLM software.[29] The study received approval from the Research Ethic Boards of St Michael's Hospital and Sunnybrook Health Sciences Centre.

Results

Table 1 shows the total number of Ontario emergency department presentations in the study sample, by method of injury and E code. Overall, for every two presentations coded DSH, one was coded UD. This ratio, however, varied by method of injury. For presentations involving non-medicinal poisoning or other injuries, UD codes outnumbered DSH codes.

Table 2 shows the rate of subsequent DSH presentation for index episodes coded DSH or UD, by E code and by method of injury at the index episode. Among those whose index episode was coded DSH, the highest rate of subsequent DSH presentation was if the index episode had involved cut/pierce injury. Rates of subsequent DSH presentation were lower for index episodes in the remaining categories (medicinal poisonings, non-medicinal poisonings and other injuries), and differences between them were less pronounced. Conversely, among those with an index episode coded UD, the rate of subsequent DSH presentation varied more—the rate for those that had involved cut/pierce injury or poisoning was nearly ten times that for other injuries [(RR (95% CI): 9.86 (6.86, 16.55)].

Regardless of method of injury, the rate of subsequent DSH presentation was higher if the index episode was coded DSH rather than UD. Overall, the rate of subsequent DSH presentation for individuals with a DSH index episode was nearly four times that of those whose index episode was coded UD. For those whose index episode involved cut/pierce injury or poisoning, the difference was much less pronounced than for those with other injuries [RR (95% CI): 2.15 (1.89, 2.48) versus 13.45 (8.84, 22.96)].

Table 3 shows factors associated with coding DSH rather than UD for index episodes that involved cut/pierce injury or poisoning. As hypothesized, method of injury, acuity and hospital admission were all significantly associated with DSH versus UD codes. Even so, the combined effects of these factors did not entirely account for the sex differences among those younger than age 65.

Table 1
Size of study sample, by method of injury and E code

Method of injury	Total number of Ontario emergency department presentations (April 11, 2001 to March 31, 2002)	E code	
		Deliberate self-harm	Undetermined
Total	24,437	15,643	8,794
Cut/Pierce	3,082	2,786	296
Poisoning (medicinal)	15,143	11,212	3,931
Poisoning (non-medicinal)	1,250	501	749
Other	4,962	1,144	3,818

Note: Because some Ontario hospitals did not submit data during the study period, the true frequency is underestimated.
Source: Ambulatory Care Reporting System, April 1, 2001 to March 31, 2002.

Table 2
Subsequent deliberate self-harm (DSH) presentation in emergency department records, by method of injury and E code at index episode, population aged 12 or older, Ontario, April 1, 2001 to March 31, 2002

Method of injury	Index episode		Subsequent DSH presentation				
	E code	Number	Number	Rate*	Relative risk	95% confidence interval	
						from	to
Total	DSH	12,394	1,421	24,618.8	3.70	3.27	4.24
	UD	7,965	275	6,644.8	1.00	...	...
Cut/Pierce	DSH	1,886	339	40,239.8	2.04	1.42	3.46
	UD	233	23	19,773.0	1.00	...	...
Poisoning (medicinal)	DSH	9,190	976	22,767.8	1.83	1.59	2.14
	UD	3,388	207	12,433.6	1.00	...	...
Poisoning (non-medicinal)	DSH	397	34	17,454.7	2.90	1.72	5.28
	UD	684	21	6,020.5	1.00	...	...
Other	DSH	921	72	16,071.4	13.45	8.84	22.96
	UD	3,660	24	1,194.9	1.00	...	...

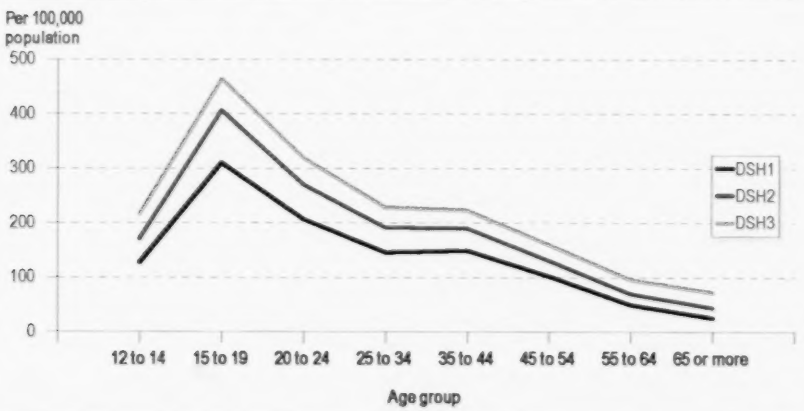
* per 100,000 person-years
... not applicable
Note: UD refers to "undetermined" method of injury.
Source: National Ambulatory Care Reporting System, April 1, 2001 to March 31, 2002.

Table 3
Factors associated with coding of deliberate self-harm (DSH) versus undetermined (UD) in index episodes involving cut/pierce injury or poisoning in emergency department records, population aged 12 or older, Ontario, April 1, 2001 to March 31, 2002

	E-code		Coding of DSH versus UD				
				95% confidence interval			95% confidence interval
	DSH (number)	UD (number)	Unadjusted odds ratio	from	to	Adjusted odds ratio	from to
Method of injury							
Cut/Pierce	1,886	233	2.25*	1.86	2.69	2.55*	2.22 2.91
Poisoning (medicinal)†	9,190	3,388	1.00			1.00	
Poisoning (non-medicinal)	397	684	0.29*	0.24	0.34	0.42*	0.36 0.48
Acuity							
Resuscitation/Emergency	4,052	1,272	1.27*	1.17	1.37	1.13*	1.07 1.20
Urgent†	6,024	2,240	1.00			1.00	
Less urgent/Non-urgent	1,397	793	0.63*	0.56	0.70	0.65*	0.59 0.72
Admission							
Yes	5,808	1,195	2.29*	2.03	2.60	1.85*	1.67 2.05
No†	5,665	3,110	1.00			1.00	
Age group and sex							
12 to 17							
Female	1,536	445	2.11*	1.76	2.54	1.81*	1.55 2.11
Male†	368	271	1.00			1.00	
18 to 64							
Female	5,736	1,712	1.47*	1.36	1.59	1.37*	1.28 1.47
Male†	3,508	1,600	1.00			1.00	
65 or older							
Female	195	169	0.93	0.69	1.26	0.98	0.73 1.32
Male†	130	108	1.00			1.00	

† reference category
* significantly different from estimate for reference category ($p<0.05$)
.. not applicable
Source: National Ambulatory Care Reporting System, April 1, 2001 to March 31, 2002

Figure 1
12-month cumulative incidence (per 100,000 population) of deliberate self-harm (DSH) in emergency department records under alternative definitions, by age group, population aged 12 or older, Ontario, April 1, 2001 to March 31, 2002



Notes: Because some Ontario hospitals did not submit data during the study period, the true incidence is underestimated. DSH1 excludes undetermined presentations. DSH2 includes undetermined presentations if they involved cut/pierce injury or poisoning methods. DSH3 includes all undetermined presentations, regardless of method.
Source: National Ambulatory Care Reporting System, April 1, 2001 to March 31, 2002.

Figure 1 illustrates the impact of alternative definitions on estimations of the 12-month cumulative incidence of DSH emergency department presentation. Overall, the estimates were 127.3 per 100,000 population (DSH1), 167.7 per 100,000 population (DSH2) and 203.9 per 100,000 population (DSH3) (data not shown). Compared with the traditional DSH definition (DSH1), DSH2 and DSH3 represented increases of 32% and 60%, respectively. Nonetheless, the shape of the curve was generally unchanged. Under each definition, DSH presentations rates peaked among 15- to 19-year-olds, and declined at older ages.

Table 4 demonstrates the effect of the alternative definitions on the relative risk of female versus male DSH presentations. DSH 2 and DSH3 attenuated the sex differences, but the effect was strongest for 12- to 17-year-olds.

Discussion

This study used a large, population-based sample from the province of Ontario to study DSH versus UD E codes in emergency department data. The findings corroborate and extend prior studies that were limited to a single hospital setting and focused on inpatient admissions. The results highlight the substantial number of injury and poisoning presentations coded UD, which, relative to DSH, are much more common in emergency department data than in data related to inpatient admissions. Canadian inpatient admission data show records coded DSH outnumber those coded UD by about five to one[30,31]; in the Ontario emergency department data on which this analysis is based, the ratio was two to one.

This study suggests that Ontario emergency department administrative data underestimate DSH because some presentations coded UD, especially those involving cut/pierce injury or poisoning, likely represent DSH. This

Table 4
Relative risk (female versus male) of deliberate self-harm (DSH) in emergency department records under alternative definitions, by age group, population aged 12 or older, Ontario, April 1, 2001 to March 31, 2002

	DSH1			DSH2			DSH3		
		95% confidence interval			95% confidence interval			95% confidence interval	
Age group	Relative risk	from	to	Relative risk	from	to	Relative risk	from	to
Total	1.60	1.54	1.66	1.46	1.42	1.51	1.27	1.23	1.30
12 to 17	3.32	3.01	3.66	2.76	2.54	2.99	2.12	1.98	2.28
18 to 64	1.48	1.42	1.54	1.36	1.32	1.41	1.19	1.16	1.23
65 or older	1.01	0.82	1.25	1.07	0.92	1.25	1.13	1.00	1.28

Notes: DSH1 excludes undetermined presentations. DSH2 includes undetermined presentations if they involved cut/pierce injury or poisoning methods. DSH3 includes all undetermined presentations, regardless of method.
Source: National Ambulatory Care Reporting System, April 1, 2001 to March 31, 2002.

observation is based on the tendency for subsequent DSH presentation. In particular, the rate of subsequent DSH presentation among those with index UD episodes that involved cut/pierce injury or poisoning was nearly 10 times that of those whose index UD episodes involved other injuries. Furthermore, the difference between DSH and UD index episodes in the rate of subsequent DSH presentation narrowed when the episodes involved cut/pierce injury or poisoning.

An analysis confined to cut/pierce injury and poisoning presentations showed that cut/pierce injury, high-acuity and hospital admission were each associated with coding DSH rather than UD. These results supported our hypotheses that lethality may be interpreted as an indication of intent, and that the hospital admission process may facilitate the detection of intent. However, the combined effects of method of injury, acuity and hospital admission could not explain why, compared with their female counterparts, males younger than age 65 were coded DSH less often.

When emergency department presentations coded UD were included as probable DSH, the estimate of the 12-month cumulative incidence of DSH increased by 60%. Under a more conservative definition that included only UD presentations that involved cut/pierce injury or poisoning, the figure increased by 32%. Both alternative definitions attenuated sex differences in DSH, particularly among youth.

Limitations

Several limitations must be acknowledged when interpreting these results.

First, because complete emergency department data are not available before the study period (2001/2002), the cohort could not be assembled from their first-ever DSH or UD emergency department presentation. Consequently, the sample included a large, but unmeasured, number of individuals with a history of DSH presentations. Such a history would influence the risk of subsequent DSH presentation and also the coding of DSH versus UD, as well as being associated with the other variables in this analysis.

Second, the analysis of subsequent DSH presentation did not account for censoring. That is, individuals who died or moved out of province after their index episode (but before the end of follow-up) were not excluded from the calculation of the person-years denominator (after their censoring event). The effect would be to overestimate the denominator, and thus, underestimate subsequent DSH presentation rates. But given the short length of follow-up (less than one year), such censoring is unlikely to have a large influence on the results.

Third, the analyses did not include injuries and poisonings coded "unintentional." Although it seems more likely that suspected DSH would be coded UD, considering the large volume of unintentional injuries and poisonings that present to the emergency department,[32] they may, in fact, represent a large absolute number of unidentified DSH.

Fourth, to maintain specificity in the outcome measure, presentations coded UD were not included in the definition of subsequent DSH, despite the finding that some may be just that.

Fifth, in the absence of a gold-standard for determining DSH, the validity of the data could not be addressed directly. Rhodes and colleagues conducted an inter-rater reliability study and latent class analysis from a sample of self-poisoning admissions to a single hospital,[12] but these methods were deemed beyond the scope of the present study, given the logistics of replicating them with so large a dataset.

Finally, administrative data do not fully capture the burden of DSH in the community. For example, in a UK study, 6.9% of students aged 15 and 16 reported DSH in the previous year, but only 1 in 8 of them presented to hospital.[33]

Conclusion

Previous research has suggested that some inpatient records coded UD may, in fact, represent DSH. Using Ontario emergency department data, a more representative source of DSH information, we found that this applies most plausibly to presentations that involve cut/pierce injury or poisoning.

The results of this study suggest that including emergency department presentations coded UD as probable DSH may be appropriate for DSH research and reporting. However, to maintain specificity (minimize false positives), identifying UD presentations that involve cut/pierce injury or poisoning methods seems advisable.

What is already known on this subject?

- Deliberate self-harm (DSH) monitoring is a component of suicide prevention strategies.
- Emergency department data offer more representative DSH information than do data on inpatient admissions.
- It is unclear whether emergency department data may still underestimate DSH, specifically, if some emergency department records coded undetermined (UD) represent DSH. Such patterns would have implications for DSH and suicide prevention, research and reporting.

What does this study add?

- Some emergency department presentations coded UD likely represent DSH, particularly those involving cut/pierce injury or poisoning.
- Among presentations involving cut/pierce injury or poisoning, the effects of method of injury, acuity and admission to hospital do not fully explain why males younger than age 65 are coded DSH (rather than UD) less often than their female counterparts.
- Including presentations coded UD as probable DSH increases DSH estimates as much as 60% and attenuates sex differences, the latter most notably in youth.

However, these measures do not address the underlying issue—the extent to which UD E codes appear in emergency department data. Kaida and colleagues offer a thorough discussion of strategies within the emergency department to improve injury surveillance data.[14] Similarly, in light of variations in E code data quality across jurisdictions, a recent US Centers for Disease Control and Prevention report recommended improving state-level data through strategies dealing with communication among stakeholders, data quality, and usefulness of the data for injury surveillance and prevention activities.[34]

The Canadian Association for Suicide Prevention has developed a blueprint for a Canadian suicide prevention strategy that, consistent with international suicide prevention strategies,[35-37] includes a monitoring component. Existing data sources, notably emergency department records, offer a likely option for this purpose. The advantages of using such sources rather than establishing specialized DSH monitoring systems[38] include low cost and complete coverage over time and geographic area. However, Canada does not currently have a national emergency department data system. NACRS, from which the data for this study were drawn, represents an opportunity to report national statistics, but the low participation rate has been cited as a limitation.[39] As of 2006/2007, NACRS emergency department data were mandated for Ontario and collected in some facilities in British Columbia, Yukon, Prince Edward Island and Nova Scotia.[40] And least one other province (Alberta) maintains emergency department data that can be used for DSH research and reporting.[4]

While the clinical implications of the results of this analysis are speculative, the implications for DSH research and reporting are more robust. Including presentations coded UD as probable DSH increased the estimated 12-month cumulative incidence. As well, the inclusion of presentations coded UD as probable DSH has implications for studying sex differences, particularly in youth.

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